Efficacy of preoperative Halo-gravity traction in severe NF-1 and CS with rotatory subluxation in thoracic spine

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# 3345, 2 yrs post-op

Unbelievable but possible!
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Difficult but achievable!
Challenging and technically demanding!
Challenge!
Rotatory subluxation

9830, Huang*, M, 17yrs, NF-1

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Rotatory subluxation

# 5913, M, 2yrs, CS

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Definition of rotational dislocation

- Displacement between two groups of vertebrae;
- Each included in a lordoscoliotic segment;
- Rotated in opposite directions.

Surgical treatment


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Surgical strategy

- **Posterior-only fusion**
  - High failure rates

- **2-incision circumferential procedures**
  - Anterior exposures;
  - Additional blood loss.

- **pVCR**
  - Comparable major curve correction

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High risk of surgery

- High apex;
- Poor blood supply (Mid thoracic region);
- Abnormal, complex anatomy of spine;
- Discontinuity of canal.
High risk of surgery

#8093, M, 17yrs, NF-1
No neurologic deficit

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High risk of surgery

#8093, M, 17yrs, NF-1
High risk!

Natural history of RS

- Progression;
- Neurological impairment.

Rapid correction can increase the risk of neurological compromise


Preoperative Halo-gravity traction

**Advantages**

- Nutritional status
- Pulmonary function
- Neurologic deficits
- Curve severity
- Gradual correction
- Better correction
- Intraoperative neurologic complications


Pre-traction: 94°

Post-traction: 75°
Surgical strategy

**Our Experience:**

- Realign dislocated spine;
- Restore the continuity of spinal cord;
- Correct spinal deformity gradually.

**Mechanism**
Surgical strategy

- PSF;
- In situ fusion;
- PSF+ concave side strut graft
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# 6417, F, 9y, CS

T10/T11
Surgical strategy

#11341, F, 11yrs, NF-1

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Post-operation

3m-post-operation

Strut graft
Concave strut graft

# 2829, Zhang KS, M, 18 y, NF1
Objective

To evaluate the efficacy of preoperative HGT in severe NF-1 and CS with rotatory subluxation.
Materials and methods

N=22

NF-1:11
Pretreatment, post-traction:
- Magnitude of RS
- Neurological complications
- Major curve
- Global kyphosis
- Pulmonary function

CS:11
Pretreatment, post-traction:
- Magnitude of RS
- Neurological complications
- Major curve
- Global kyphosis
- Pulmonary function

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Measurement of lateral/anterior translation

Lateral translation

Anterior translation

## Results

Table 1. Efficacy of HGT in all patients

<table>
<thead>
<tr>
<th></th>
<th>Pre-traction</th>
<th>Post-traction</th>
<th>Correction rate (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major curve</strong></td>
<td>105.45 ± 34.26</td>
<td>81.23 ± 32.68</td>
<td>21.07 ± 14.08</td>
<td>*</td>
</tr>
<tr>
<td><strong>Global kyphosis</strong></td>
<td>79.27 ± 22.53</td>
<td>66.89 ± 23.06</td>
<td>22.81 ± 15.54</td>
<td>*</td>
</tr>
<tr>
<td><strong>Lateral translation (mm)</strong></td>
<td>9.37 ± 5.28</td>
<td>6.41 ± 3.67</td>
<td>30.31 ± 14.54</td>
<td>*</td>
</tr>
<tr>
<td><strong>Anterior translation (mm)</strong></td>
<td>7.57 ± 3.52</td>
<td>5.03 ± 2.35</td>
<td>34.76 ± 22.22</td>
<td>*</td>
</tr>
</tbody>
</table>
NF-1 with RS

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Pre-traction
3m-post-traction
Post-op
7m-post-op

L6/7 = 21.82mm
L6/7 = 17.06mm
L6/7 = 7.95mm
L6/7 = 5.99mm

50°
42°
12°
5°
L6/7 = 10.75mm, 87°
L6/7 = 7.50mm, 85°
L6/7 = 3.88mm, 54°
L6/7 = 4.46mm, 53°

Pre-traction, 3m-post-traction, Post-op, 7m-post-op

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## Results

### Table 2. Efficacy of HGT in NF-1

<table>
<thead>
<tr>
<th>NF-1</th>
<th>Pre-traction</th>
<th>Post-traction</th>
<th>Correction rate (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major curve</td>
<td>90.30 ± 26.10</td>
<td>69.67 ± 23.21</td>
<td>24.60 ± 14.56</td>
<td>0.002</td>
</tr>
<tr>
<td>Global kyphosis</td>
<td>75.6 ± 16.30</td>
<td>59.00 ± 14.58</td>
<td>23.75 ± 14.27</td>
<td>0.006</td>
</tr>
<tr>
<td>Lateral translation(mm)</td>
<td>10.48 ± 6.75</td>
<td>7.61 ± 4.09</td>
<td>32.66 ± 14.89</td>
<td>0.01</td>
</tr>
<tr>
<td>Anterior translation(mm)</td>
<td>8.47 ± 3.31</td>
<td>5.40 ± 2.55</td>
<td>37.59 ± 22.92</td>
<td>0.003</td>
</tr>
</tbody>
</table>
## Results

Table 3. Efficacy of HGT in CS

<table>
<thead>
<tr>
<th>CS</th>
<th>Pre-traction</th>
<th>Post-traction</th>
<th>Correction rate (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major curve</td>
<td>127.55 ± 16.49</td>
<td>100.90 ± 23.31</td>
<td>17.53 ± 12.63</td>
<td>0.003</td>
</tr>
<tr>
<td>Global kyphosis</td>
<td>83.45 ± 27.13</td>
<td>74.78 ± 26.95</td>
<td>21.87 ± 16.67</td>
<td>0.004</td>
</tr>
<tr>
<td>Lateral translation (mm)</td>
<td>8.26 ± 2.80</td>
<td>5.90 ± 2.55</td>
<td>27.96 ± 13.80</td>
<td>0.0001</td>
</tr>
<tr>
<td>Anterior translation (mm)</td>
<td>6.67 ± 3.49</td>
<td>4.67 ± 2.06</td>
<td>31.94 ± 21.13</td>
<td>0.017</td>
</tr>
</tbody>
</table>
## Results

### Table 4. Changes in patients with neurological deficits

<table>
<thead>
<tr>
<th>Patient number</th>
<th>sex</th>
<th>age</th>
<th>traction</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF1 1</td>
<td>M</td>
<td>20</td>
<td>+</td>
</tr>
<tr>
<td>NF1 2</td>
<td>M</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>NF1 3</td>
<td>M</td>
<td>18</td>
<td>+</td>
</tr>
<tr>
<td>NF1 4</td>
<td>M</td>
<td>6</td>
<td>+</td>
</tr>
<tr>
<td>CS 5</td>
<td>F</td>
<td>10</td>
<td>+</td>
</tr>
<tr>
<td>CS 6</td>
<td>M</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>CS 7</td>
<td>F</td>
<td>15</td>
<td>-</td>
</tr>
</tbody>
</table>

“+”: improved after traction  
“-”: no change after traction
## Results

Table 5. Results of surgical correction in all patients

<table>
<thead>
<tr>
<th>All patients</th>
<th>Pre-op</th>
<th>Post-op</th>
<th>Final follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major curve</td>
<td>105.45 ± 34.26</td>
<td>51.2 ± 12.7</td>
<td>53.6 ± 12.1</td>
</tr>
<tr>
<td>Global kyphosis</td>
<td>79.27 ± 22.53</td>
<td>36.3 ± 10.8</td>
<td>36.8 ± 11.5</td>
</tr>
<tr>
<td>Lateral translation (mm)</td>
<td>9.37 ± 5.28</td>
<td>5.2 ± 3.2</td>
<td>5.1 ± 4.1</td>
</tr>
<tr>
<td>Anterior translation (mm)</td>
<td>7.57 ± 3.52</td>
<td>4.9 ± 3.7</td>
<td>4.6 ± 2.8</td>
</tr>
</tbody>
</table>
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Complications

Complications of HGT

- Pin loosening: 3 cases
- Superficial pin site infections: 1 case
- Numbness of the mouth: 2 cases
Perioperative surgical complications

- CS (2 cases)
  - Screw malposition
- NF-1 (1 case)
  - Screw malposition (T7)
- NF-1 (1 case)
  - Intraoperative massive blood loss
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Patients</th>
<th>Etiology</th>
<th>Coronal Correction (°)</th>
<th>Sagittal Correction (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watanabe</td>
<td>2010</td>
<td>21</td>
<td>severe scoliosis (≥100°)</td>
<td>61</td>
<td>24</td>
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<tr>
<td>Zeller</td>
<td>2000</td>
<td>11</td>
<td>short sharp angled kyphosis</td>
<td>28</td>
<td>45</td>
</tr>
<tr>
<td>Sink</td>
<td>2001</td>
<td>19</td>
<td>neuromuscular, idiopathic, and congenital scoliosis</td>
<td>39</td>
<td>48</td>
</tr>
<tr>
<td>Janus</td>
<td>2000</td>
<td>20</td>
<td>severe scoliosis in osteogenesis imperfecta</td>
<td>31</td>
<td>40</td>
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<tr>
<td>Rinella</td>
<td>2005</td>
<td>33</td>
<td>severe scoliosis, kyphoscoliosis, or kyphosis</td>
<td>46</td>
<td>34</td>
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<tr>
<td>Park</td>
<td>2013</td>
<td>525</td>
<td>severe scoliosis, kyphoscoliosis, or kyphosis</td>
<td>40</td>
<td>46</td>
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<tr>
<td>Current study</td>
<td>2014</td>
<td>22</td>
<td>congenital scoliosis, NF-1</td>
<td>56</td>
<td>45</td>
</tr>
</tbody>
</table>
# Surgical Outcome of Rotational Dislocation in Kyphoscoliotic Deformities

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Patients</th>
<th>Etiology</th>
<th>Coronal Correction (°)</th>
<th>Sagittal Correction (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vandenbroucke</td>
<td>1997</td>
<td>2</td>
<td>NF-1</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>Zeller</td>
<td>2000</td>
<td>11</td>
<td>short sharp angled kyphosis</td>
<td>31</td>
<td>48</td>
</tr>
<tr>
<td>Stoker</td>
<td>2012</td>
<td>1</td>
<td>NF1</td>
<td>42</td>
<td>53</td>
</tr>
<tr>
<td><strong>Current study</strong></td>
<td>2014</td>
<td>22</td>
<td>congenital scoliosis, NF-1</td>
<td>38</td>
<td>47</td>
</tr>
</tbody>
</table>
Mechanism of rotational subluxation

Rotated in opposite directions
Anterior column malformation

# 6417, F, 9y, CS
Neurologic Deficits

Mechanism

- Not From Compression
- Just From Canal Discontinuity
Conclusions

Preoperative HGT is a safe, well-tolerated method to improve coronal curve and sagittal kyphosis for CS and NF-1 patients associated with rotational subluxation.
Thank you!